

Bike Parkade



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Bike Parking Operational Framework

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Introduction

1.1 Problem Statement and Objectives

1.2 Report Structure

1.1 Problem Statement and Objectives

Combining bikes and transit promotes healthy lifestyles and is good for the environment. It also increases accessibility to transit and overall sustainability of the network. In order to further connect cycling and transit, it is important to provide options not only for people to bring bikes on transit, but also to securely and safely park bikes at transit facilities.

This project recognizes the importance of bike parking at transit facilities, and serves as a guide to encourage further integration between cycling and transit. The purpose of this framework is to help plan and prioritize future investment and capital expenditures in bike parking at transit facilities. This project assesses transit facilities and their surroundings on bike opportunity in order to determine which facilities should be prioritized for future investments in bike parking. This tool can be used to identify and direct potential projects and spending. This can more effectively promote the combination of cycling and transit at facilities that show the greatest opportunity.

In addition to directing future projects and spending, this project ties into a number of larger objectives. These include:

- Accomodate and encourage bicycle access to transit
- Support sustainable travel methods and choices
- Promote bike parking to meet the needs of cyclists throughout the network
- Improve the experience of combining bikes and transit at a range of facilities

1.3 Report Structure

This report is structured into five main sections to outline the background to the research, guiding case studies, and the framework itself.

The first section of the report describes the context. This begins with a focus on the role of cycling and transit in Metro Vancouver. This section provides an overview of the existing connections between bikes and transit, and describes potential opportunities. In addition to this regional background, this section outlines the larger context of transit and cycling integration, and describes existing opportunities and constraints in expanding this integration.

Building on this background, the next section presents a number of case studies of bike parking at or near transit facilities in cities around the world. This precedent study presents the full range of bike parking options from fully automated systems to simple bike racks. Each bike parking type is assessed on a number of factors including cost, security and accessibility. This provides a basis for determining which bike parking options may be best suited to the context and needs of Metro Vancouver and TransLink.

The next portion of the report is dedicated to describing the methodology of creating the framework. This describes ways in which the methodology was modeled off of previous analysis, to create a framework that fits in and relates to other projects. Next, there is a description of the specific tools and processes used in the analysis. This

includes a GIS buffer analysis using network buffers and several variables determined to affect the opportunity for cycling. This section describes how and why each variable was weighted to determine a points score for each location. Building this points system involved a number of assumptions, and the scores have limitations in predicting bike opportunity accurately. These assumptions and limitations are also described in this section.

The maps of the buffers and variables as well as the table of scores are presented in the analysis section of the report.

Finally, the last section of the report provides the findings and conclusions and suggests ways the framework could be applied and next steps that could build on this work.



Context

2.1 TransLink and Cycling in Metro Vancouver

2.2 Bike and Transit Integration

2.1 TransLink and Cycling in Metro Vancouver

Cycling is one of the healthiest and most sustainable methods of travel available in Metro Vancouver, and it can be the fastest as well, especially in more urban areas of the region. In order to promote biking and all of the benefits associated with it, TransLink is committed to providing connections and services for bikes (TransLink, n.d.).

First, TransLink provides many options for bringing bikes on transit in order to help connect bikes and transit and provide accessibility across the network. Bikes can be taken on the bus, SkyTrain, SeaBus and West Coast Express. Each TransLink bus is equipped with a rack at the front of the bus with space for two bikes. TransLink provides instructions for use of the racks and video demonstrations online. There are also two Rack and Ride demo stations at Main Street- Science World in Vancouver and City Hall Plaza in the City of North Vancouver (TransLink, n.d.).

Bikes are allowed on board SkyTrain, though there may be restrictions in hours and capacity depending on the line. Bikes are also permitted on board the SeaBus and West Coast Express at any time, though there is limited capacity in both cases.

In addition to options to bring bikes on transit, TransLink also offers a variety of options throughout the network to park bikes at transit facilities.

There are currently three different types of parking available at SkyTrain stations, bus exchanges and West Coast Express stations throughout Metro Vancouver. First, standard outdoor bike racks are available at all SkyTrain stations and most bus exchanges.

Bike Parkades are indoor facilities with multiple bike racks available only to registered users. Bike Parkades are currently available at King Edward, Main Street - Science World, Commercial - Broadway, Joyce - Collingwood, Metrotown, King George, and Port Coquitlam stations. Future Bike Parkades are planned for Bridgeport, Burquitlam, Lafarge - Lake Douglas and Maple Meadows stations. Parkades are lit 24 hours a day and equipped with security cameras. Registered users can access Bike Parkades using their Compass Card for a fee of \$1 per day with a monthly cap of \$8.

Bike Lockers are also available throughout the region. Lockers typically best meet the needs of regular commuters as they are rented for an extended period of time at a specific station. At SkyTrain Stations, Bus Exchanges and West Coast Express stations, Bike Lockers can be rented for \$10 per month. At SkyTrain Stations and Bus Exchanges there is also a \$50 refundable key deposit and a minimum rental period of 3 months. The refundable key deposit at West Coast Express stations is \$10 and there is no minimum rental period (TransLink, n.d.).

2.2 Bike and Transit Integration

There are many reasons to expand the integration of bikes and transit. Research shows that successfully joining biking and transit can increase the use and catchment area of transit, improve the overall efficiency of the transit network and reduce the need for car parking at transit facilities (Krizek and Stonebraker, 2011). These advantages have been well studied, as have the many beneficial reasons for biking including addressing health, the environment and congestion (Krizek and Stonebraker, 2011)

Connecting bikes and transit can allow people to access transit from farther away. Surveys in Philadelphia and San Francisco suggest that transit users were willing to bike over 10 times a greater distance than they were willing to walk to access transit. In addition, when covering the same distance, biking allowed users to reach transit 2 to 3 times faster than walking (Flamm and Rivasplata, 2014).

According to GPS analysis in Cincinnati, “riding a bicycle to transit stops can make the first and last miles easier and less costly in terms of travel time. Connecting bicycle with transit could allow transit services to be accessible from more distant areas” (Zuo, Wei and Rohne, 2018). Connecting bikes and transit promotes greater accessibility and coverage in addition to benefitting overall health and sustainability.

Despite this, one significant barrier to integrating biking and transit in North America is a lack of secure bike parking. Because biking has often not been integrated into transit networks from the start, in many cases there is a shortage of parking, and what is available may be subject to theft or vandalism and may not offer adequate weather protection (Replogle, 1993). This is an especially important problem to address. Studies across multiple locations have shown that the availability of bike parking has significant influence on people’s decision on whether to bike to transit (Heinen and Buehler, 2019).

Therefore, if there is a lack of parking at transit facilities, people will be less likely to use bike as a mode of access. In addition, the presence of damaged or vandalized bikes is a deterrent to parking (Heinen and Buehler, 2019). In order to encourage the link between biking and transit, it is therefore necessary to provide and availability of safe and secure parking options.

Precedent Study

2.1 Introduction

2.2 High Ridership

2.3 Medium Ridership

2.4 Low Ridership

2.1 Introduction

The purpose of this precedent study is to identify best practices of bike parking from cities, companies and transit authorities around the world. These case studies are divided into categories based usership and parking type. The three categories are High Ridership, Medium Ridership and Low Ridership. These categories are intended to describe only the general characteristics of each example. Not every example is directly connected to a transit facility, and these groups are not derived from ridership data. Instead, the intention is to divide the examples based on the relative number of riders they are designed to accommodate.

Within these three categories the examples are further divided by parking type. The types are as follows: High Ridership examples are split into Mechanized and Smart Systems, Large-Scale Parking Facilities, and Sheltered Parking. Medium Ridership examples are split into On-Demand Lockers, Single User Lockers, and Bike Cages. The Low Ridership examples are split into Covered Bike Racks and Bike Racks.

Within each category section, the parking types presented are assessed on cost, security, space, capacity, accessibility and installation. As with the determination of the categories, this assessment describes only the general characteristics of each type. It is not a quantitative comparison of data for each variable. Instead, the summary tables are meant to provide an overall view of the relative differences between the parking types.

Each variable is de scribed as an opportunity, potential or shortcoming. For example, in the summary assessment of fully automated underground storage systems like those found in the case studies of Tokyo and Barcelona, security is ranked as an opportunity, because these parking types provide almost guaranteed security. However, cost is ranked as a shortcoming, as the cost of construction and maintenance is high. In this way, the summary tables describe the relative values and limitations of each bike parking type presented.



Free valet parking is available at some BART Bike Stations including Downtown Berkeley, pictured above (BART, n.d.).

2.2 High Ridership

Features

Ridership



The transit facilities within this category typically have relatively high ridership within local and regional contexts.

Context



These examples are typically located in more urban contexts. This is also often associated with low space availability.

Access



There is generally a lower level of car access or availability of parking, so station access by walking and bike is more important at these types of facilities.

Security



Theft may also be more common near these facilities, so security in bike parking is a priority.

Cost



The parking facilities described in this section may require higher costs for installation or operation.

Description

In some of the examples, the bike parking solutions were implemented by private companies, while others were implemented by cities, and some were partnerships between companies and transit authorities.

Mechanized and Smart Systems

The first type of facility is Mechanized and Smart Systems. These are technology-based facilities that are generally a higher cost to install and maintain but can provide high levels of security. For example, the Spanish company Biceberg guarantees security of all bikes in its facilities (Biceberg, n.d.). This level of security can also allow users to store their helmets and bike accessories without fear of theft (Intelligent Energy Europe).

Fully automated systems like those shown here in Tokyo, Spain and the Czech Republic were typically run by private companies rather than by cities or transit authorities. However, they sometimes work in partnerships with local or national public transit, as seen in the Czech Republic, where riders can use In-Karta transit cards to pay for bike parking operated by BIKETOWER (BIKETOWER, n.d.). These systems are easy to use and accessible. However, they can be costly and may require complicated construction. Another potential shortcoming of fully automated systems like those seen in Japan, the Czech Republic and Spain is that they may result in long lines to store or retrieve bikes during rush hour (Intelligent Energy Europe).

Large-Scale Parking Facilities

The second type of precedent in this section is Large-Scale Parking Facilities. These are purpose-built structures designed to accommodate a large number of bikes with secured indoor parking. Each of the examples was built in close proximity to or connected to a large transit hub.

The Stationsplein in Utrecht is close to Utrecht Central Station and is jointly run by the city, ProRail and NS (Dutch Rail) (City of Utrecht, n.d.). Similarly, Malmo's Bike and Ride facility is located below Malmo Central Station and has direct access to both bus and train platforms (Copenhagenize, 2014). While Washington D.C.'s Bikestation is no longer in operation, it was designed to serve a similar purpose. It is located just outside of Union Station, the busiest train station in the city (NoMa, 2009).

In each case, these large-scale facilities have been promoted by their cities as examples of accomplishments in bike infrastructure. For example, the City of Utrecht has claimed Stationsplein to be the largest facility as well as the "only manned and monitored bicycle parking where indoor cycling is permitted" (City of Utrecht, n.d.). Similarly, Washington D.C. claimed Bikestation to be "the first of its kind on the East Coast" (NoMa, 2009). In this way, these highly designed large-scale facilities may also serve as an attraction within their cities.

Sheltered Parking

The third type of precedent in the High Ridership section is Sheltered Parking. These examples are somewhat similar to the Large-Scale Parking Facilities in that they offer secure indoor parking. However, they are typically rooms located within transit facilities rather than separately built and designed structures.

These facilities offer varying degrees of security. BART, WMATA and the City of Toronto all require forms of registration for the use of their parking facilities. Bicycle Parking Stations in Toronto are staffed during some hours, as are the valet parking options at BART's BikeHubs. WMATA Metro Bike and Ride facilities are protected by security cameras (WMATA, n.d.). There is also the option to incorporate other features with this type of facility. For example, some of BART's BikeHubs have repair stations, bike accessory shops or coffee shops (BART, n.d.). Because these facilities operate within existing transit facilities they may require lower costs to set up and run.

Locations Studied

Tokyo

Europe

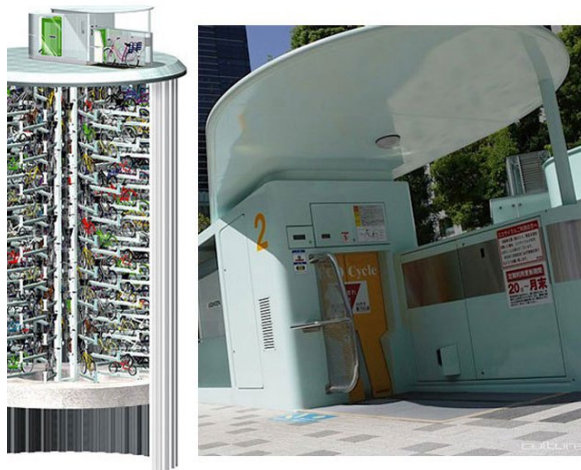
- Czech Republic
- Barcelona, Spain
- Malmo, Sweden
- Utrecht, Netherlands

North America

- Bay Area
- Toronto
- Washington D.C.

Tokyo, Japan

Underground mechanized bike storage systems are common in Tokyo as well as other major Japanese cities. The systems originated with the Japanese company Eco Cycle. They provide mass storage without taking up much space on the street level, and they offer a high level of security (Eco Cycle, n.d.). The facilities are accessible, easy to use and seismically safe. However, they are expensive and require extensive construction during installation.



Czech Republic

Mechanized bike storage systems are also gaining popularity in Europe. The image to the left shows a system by BIKETOWER in Pardubice, Czech Republic (BIKETOWER, n.d.). The system works in a similar way to the Eco Cycle systems in Japan, with above ground storage rather than below. The company has similar systems at major train stations in other cities in the Czech Republic as well. While BIKETOWER is a private company, they have partnerships with Czech Railways in some cities to allow cyclists to use In-Karta transit cards as a payment option.



Barcelona, Spain

The Spanish company Biceberg is another example of an automated bike storage system. There are currently Biceberg storage systems in Barcelona and a few nearby cities, with plans to install more systems at train stations in the region and ambitions to expand into the rest of Europe (Biceberg, n.d.).



Bay Area, United States

In 2017, BART began a pilot partnership with Bikeep to bring smart, secure bike racks to a few major stations (BART, 2018). The racks are free to use and are linked to users' transit cards to lock and unlock. Bikes can be kept at the racks for up to 24 hours. Bikeep has installed over 1,000 racks in 9 countries since 2013, and there have been zero thefts in the past 5 years (Bikeep, n.d.).



Large-Scale Parking Facilities

Utrecht, The Netherlands

The final stage of the Stationsplein Bicycle Parking opened in August 2019. It is located below Utrecht Central Station, the largest public transport hub in the Netherlands, and is the largest bike parking facility in the world with a capacity for 12,500 bikes. It is collectively managed by the municipality of Utrecht, ProRail and NS (Dutch Rail). It is open 24 hours a day, and the first 24 hours of parking are free. It is the only manned and monitored bike parking facility where riding is allowed indoors (City of Utrecht, 2019).



Malmö, Sweden

The Bike and Ride facility at Malmö Central Station offers capacity for 1,500 bikes as well as dedicated spaces for cargo bikes. It also includes lockers, showers, a lounge, bike repairs and a shop. The facility is free to use and is patrolled during the day by a guard. A secured section with capacity for 700 bikes is also available for a subscription fee. The facility is brightly colored and connects directly to bus and train platforms above (Copenhagenize, 2014).



Large-Scale Parking Facilities

Washington D.C., United States

Bikestation, designed by architects KPG Design, opened in 2009. The building is located at Union Station, which is the busiest train station in the city. The facility offered indoor bike storage, repairs and rentals. Outdoor bike racks are also available around the structure (NOMA, 2009).

However, as of 2019 Bikestation is no longer in operation and the future use of the space is unknown.



Sheltered Parking

Bay Area, United States

BART has been expanding its selection of secure bike parking with Bike Stations at major stations throughout the network. The Bike Stations have a range of amenities depending on factors like location and size. These amenities include valet parking, controlled access rooms, bike repairs, bike accessory sales and cafes. Where controlled access areas exist, they are available for a small hourly fee. At available stations valet is free during the day. Bikes can be left for up to 10 days at a Bike Station (BART, n.d.).



Toronto, Canada

The City of Toronto offers secure bike storage rooms at major stations. These facilities are only accessible with registration and membership fees. Separate monthly plans must be purchased to access each station in addition to the membership fee. The bike stations are protected with 24 hour video surveillance. While they are not directly connected to transit facilities, most are located close by (City of Toronto, n.d.).



Sheltered Parking

Washington D.C., United States

Metro Bike and Ride now operates secure bike parking at College Park - U of Md Station, with more facilities under construction at East Falls Church and Vienna. More stations are expected to follow. The Bike and Ride facilities are free to use at all stations with a membership registration. Until recently Bike and Ride was operated by a third party and required fees. The facilities have capacity for 120 bikes and are equipped with security cameras and emergency phones (WMTA, n.d.).



Summary Table

● opportunity ○ potential ◌ shortcoming

	Cost	Security	Space	Capacity	Accessibility	Installation
High Ridership Precedents						
Mechanized and Smart	◌	●	●	●	●	◌
Large-Scale Parking	◌	●	◌	●	●	◌
Sheltered Parking	○	○	○	●	●	○



Stationsplein Bicycle Parking in Utrecht is the largest bike parking facility in the world and is unique in allowing users to bike indoors. (City of Utrecht, n.d.).

2.3 Medium Ridership

Features

Ridership



The transit facilities within this category typically have mid-level ridership within local and regional contexts.

Context



These examples are typically located in a mix of urban and suburban contexts. This means space is not as primary of a concern

Access



There is generally a mix of car access with pedestrian and bicycle access.

Security



Theft may still be a problem, but it is a lower concern than in high ridership contexts.

Cost



These examples of bike parking facilities are typically lower cost than the High Ridership examples, but in some cases still require moderate costs for installation and operation.

Description

On-Demand Lockers

The first type of bike facility described in this section is On-Demand Lockers. The examples shown are run by BART and King County Metro in Seattle. In both cases the On-Demand Lockers are BikeLink lockers. BikeLink lockers can be accessed with a card and work like a parking meter to charge for the time used, even refunding unused time when the bike is removed (BikeLink, n.d.). This allows users to have more flexibility and use lockers throughout a transit network, rather than completing a long-term rental at a single station.

At BART stations, the hourly fees to use the lockers are dependant on the availability (BART, n.d.). BikeLink advertises a clear and easy to use interface and low operating costs. In addition, the BikeLink lockers can serve 5-7 times as many cyclists in a year compared to single user lockers (BikeLink, n.d.). In addition to King County Metro and BART, BikeLink also operates with several other transit authorities and cities in the United States.

Single User Lockers

The second type of facility is Single User Lockers. Single User Lockers are typically intended for long-term bike parking and are rented for periods at single stations. The time periods available vary by case. WMATA offers only yearly rental periods (WMATA, n.d.). Toronto requires a minimum rental period of 4 months (City of Toronto, n.d.). Sydney offers rentals in 3-month periods (Transport NSW, n.d.).

Locker rentals are subject to availability, and in some cases may require long wait lists (City of Toronto, n.d.). The lockers in each of these examples use a unique key for each user to maximize security.

Bike Parkades

The third bike parking type described is Bike Parkades. Bike Parkades are secure rooms that with bike racks. They typically require card access to enter. In Sydney, this can be combined with a transit card to tap in and out of the facility (Transport NSW, n.d.). In Melbourne, however, a separate card is required for access, as the Parkiteers are operated by a private company (Bicycle Network, n.d.). And in Seattle, Bike Parkades are accessed by a keycode (Sound Transit, n.d.).

There are also varying payment and registration methods. In all cases, it is recommended that users still use their own locks within the Bike Cages, as all registered users have equal access, so the parking may not be entirely secure. In some cases, there are two levels of bike racks available. Typically, Bike Cages can accommodate 20-50 bikes (Transport NSW, n.d.).

Locations Studied

Australia

- Melbourne
- Sydney

North America

- Bay Area
- Toronto
- Seattle
- Washington D.C.

On-Demand Lockers

Bay Area, United States

BART has installed on-demand BikeLink lockers, which are available at a first-come first-served basis. The lockers require online registration and a BikeLink smart card to use. The lockers are locked and unlocked with the card, which also works as payment for the fees of 3- 5 cents per hour depending on capacity. Registration and the card provide access to and of the BikeLink lockers in the system. Single-user lockers are also available at some stations (BART, n.d.).



Seattle, United States

King County Metro in Seattle also offers BikeLink lockers at some stations. The system works largely the same way as BART, with registration, card access, fees of 5 cents per hour and availability on a first-come first-served basis. Currently BikeLink lockers are available at a few stations, but spreading throughout network to meet demand that exceeds existing single-user lockers. The lockers can be rented for up to 10 days, but if a bike is left for longer than 14 days it will be considered abandoned and removed (King County, n.d.).



Single User Lockers

Sydney, Australia

Transport NSW offers over 950 bike lockers at 130 interchanges across the public transit network. Each locker has unique locks and keys and can be rented for a \$50 key deposit in addition to monthly payments in 3 month periods. Following the application process, the key will be mailed to the renter, and at the end of the period the deposits are refunded within 30 days of key return (Transport NSW, n.d.).



Toronto, Canada

The City of Toronto offers bike lockers near several transit stations. These lockers have unique locks and keys and can be rented for \$10 a month for a minimum of 4 months. Rental involves an application process and payments can only be made in person at three locations. There are a limited number of lockers available so there may be wait lists at some locations depending on demand (City of Toronto, n.d.).



Single User Lockers

Washington D.C., United States

There are approximately 2,400 lockers available in the Washington D. C. Metro network. Each locker has a unique lock and key. Rentals are available for a one year period based on availability. The rental fee is \$120 per year. These lockers are intended for long-term or regular users (WMATA, n.d.).



Melbourne, Australia

Parkiteer is a service provided by Public Transit Victoria and operated by the private company Bicycle Network. The parkiteers are located at stations in Melbourne and major regional stations throughout Victoria. They are free to use, but require a \$50 deposit for key card and \$10 for card replacement. Registered users can access any Parkiteer. Registration is completed online and it then takes 5-7 days for card to arrive (Bicycle Network, n.d.).



Seattle, United States

Bike cages are available at three stations in the Sound Transit network. The bike cages offer two-tiered parking racks to increase capacity, and can be accessed by keycode. A \$50 fee provides users with access to all bike cages. Because all users have equal access, bikes must still be locked to the racks inside the bike cages (Sound Transit, n.d.).



Sydney, Australia

Bike sheds are available in the Transport NSW network. The sheds provide capacity for 20 to 50 bikes depending on the size and location. Bike sheds are free to use, but require an online registration which is then linked to the user's transit card. The card is required both to enter and exit the shed to prevent unauthorized access (Transport NSW, n.d.).



Summary Table

● opportunity ○ potential ⦿ shortcoming

	Cost	Security	Space	Capacity	Accessibility	Installation
Medium Ridership Precedents						
On-Demand Lockers	⦿	●	⦿	⦿	●	○
Single User Lockers	○	●	⦿	⦿	○	○
Bike Parkades	○	○	○	●	●	○

2.4 Low Ridership

Features

Ridership



The transit facilities within this category typically have low ridership within local and regional contexts.

Context



These examples are typically located in suburban contexts. This is also often associated with greater space availability.

Access



There is generally a higher level of car access to these facilities.

Security



Theft is likely less of a concern at these facilities.

Cost



These bike parking facilities are typically lower cost to install and operate.

Description

There are two types of bike parking facilities described in this section.

Covered Racks

The first is Covered Bike Racks. These racks offer greater protection from weather, so may be more appealing to users. In addition, some of the examples are two-tiered parking, which can increase capacity while using the same amount of space (BART, 2012).

Bike Racks

The second type of bike parking facility in this section is Bike Racks. Networks like BART and WMATA have Bike Racks at most stations. Different types of racks offer varying degrees of security. WMATA is in the process of replacing older racks with Inverted-U racks that are more secure (WMATA, n.d.). While the City of Toronto also operates year-round bike racks, the example shown here is the Bike Corral Program, which creates bike parking spaces during the summer to promote cycling and reduce sidewalk congestion (City of Toronto, n.d.). This shows another possibility for bike parking to change to meet seasonal need.

Locations Studied

Australia

- Melbourne

North America

- Bay Area
- Toronto
- Washington D.C.

Covered Bike Racks

Bay Area, United States

Covered bike racks are available at many BART stations of all ridership levels. Covered racks offer greater weather protection and two tiered parking offers higher capacity, so they may be preferable to other types of racks (BART, 2012).



Washington D.C., United States

Bike racks are available at most Metro stations, with covered racks available at certain stations to provide greater weather protection (WMTA, n.d.).



Covered Bike Racks

Melbourne, Australia

Bike racks or hoops are available at almost all transit stations in Melbourne and throughout Victoria. In some cases there are multiple racks in a station for added convenience. Some two tiered covered racks are also being added to increase capacity (Public Transport Victoria, n.d.).



Bay Area, United States

Bike racks are available at almost all BART stations. In cases where racks are available both inside and outside of fare gates, users tend to prefer racks inside fare gates. These are perceived as more secure (BART, 2012).



Washington D.C., United States

Metro currently owns and operates over 2,400 bike racks throughout its network. Older racks are currently being replaced by new, more secure inverted-U racks (WMTA, n.d.).



Toronto, Canada

The City of Toronto began installing seasonal bike corrals at busy locations, often near transit, in 2010. The corrals occupy car parking in the curb lane to prevent congestion on sidewalks. Typically they can accommodate 14 bikes in a space for one car. The corrals are removed before ploughing season starts on December 1st, and reinstalled in the spring (City of Toronto, n.d.).



Summary Table

● opportunity ○ potential ⦿ shortcoming

	Cost	Security	Space	Capacity	Accessibility	Installation
Low Ridership Precedents						
Covered Bike Racks	○	⦿	○	●	●	○
Bike Racks	●	⦿	●	●	●	●

Methodology

4.1 Buffer Analysis

4.2 Variables and Scoring

4.3 Assumptions and Limitations

4.1 Buffer Analysis

Background

A GIS buffer analysis was used in order to assess the opportunity for biking around each transit facility. First, it was determined that the average distance people are willing to bike in order to access transit is approximately 2.5 kilometers. This number was determined based on research and assessments in cities around the world.

Surveys in San Francisco and Philadelphia showed that the majority of riders would not bike more than 4 kilometers to reach transit, though some were willing to bike much longer distances (Flamm and Rivasplata, 2014). In the Netherlands, where 30% of transit users access stations by bike, cycling was the primary mode of access under 3 kilometers. A similar result was found in Germany, where transit users were willing to bike up to 4 kilometers. However, other cities had much lower biking distances. In Atlanta, people were willing to bike on average only 1.7 kilometers (Hochmair, 2015). Other research has shown that people are willing to bike greater distances on the home end of their transit trip than on the work or activity end (Zuo, Wei and Rohne, 2018).

While this research provides helpful insight on combining bikes and transit, there is still relatively little research on travel distances compared to pedestrian or vehicle access. In addition, there is no data yet available on the distance transit users are willing to bike in Vancouver.

However, for the purpose of this framework it was determined that a general range would be appropriate to complete the analysis.

Based on the existing research described above, 2.5 kilometers was determined to be the average distance of bike access around transit facilities for the purpose of this framework.

Network Buffers

Because the focus of the analysis is on biking, the access around transit facilities are determined by bikeable networks. Therefore, a network buffer was used instead of a simple round buffer in order to gain a more accurate understanding of the surroundings. The network was built using both bike lane data from Open Street Map (Open Street Map Contributors, 2020) and street data from the Metro Vancouver Open Data Catalogue (Metro Vancouver, 2018), as bikes can travel both in designated bike lanes and along roads and streets. However, roads that create barriers to biking such as highways and freeways were removed from the network analysis.

After this network was built, it was used to create buffers of 2.5 kilometers around each facility. This framework focuses just on the higher priority facilities as defined by the Bus Customer Amenity Program (BCAP). The BCAP Tier 1 and Tier 2 facilities are characterized by higher ridership, regional significance and connectivity. The network buffers were constructed only around these facilities. Much of the analysis and methodology of this framework also draws from BCAP. Factors that were used in BCAP including regional significance and ridership could also provide insight into bike parking and investment opportunity.

Connecting and relating to this existing work enhances the value and use of this framework as a tool to apply to future projects.

In order to determine the opportunity for biking around each transit facility, several variables were applied to the buffer analysis. These variables were selected for their relevance to bikeability. While some of them might overlap with characteristics of overall transit or ridership opportunity, this was not the focus as these factors are already assessed in the BCAP analysis. As the framework already focuses only on the Tier 1 and Tier 2 facilities, it would be redundant to repeat variables from BCAP in this analysis.

4.2 Variables and Scoring

Mode Share

The first variable included in the analysis is Mode Share. This census data describes the percent of people in each municipality who use active modes of transportation in some part of their commutes. While active transportation is not specific to only biking, it could suggest that areas where more people use active transportation for some part of their commute could provide more opportunities for connecting bikes and transit.

Population Density

The third variable is Population Density. This variable was chosen because areas of higher density also have the potential for a higher number of cyclists, and should be planned for accordingly. While this does not speak to the current number of cyclists, it does suggest that there is an opportunity in high density areas to encourage more people to combine bikes and transit.

Bike Infrastructure

The second variable is Bike Infrastructure. This layer was created using data from Open Street Map (Open Street Map Contributors, 2020). This was done in order to maintain consistency across each municipality, rather than relying on separate open datasets from each municipality, which may be constructed from differing definitions of bike infrastructure and may not be available for each location. The total length of existing bike infrastructure within each buffer was calculated.

Land Use

The final variable in the buffer analysis is Land Use. For the purposes of this analysis, land use was divided into three general categories: Industrial/Agricultural, Residential and Commercial. Industrial/Agricultural land likely provides less opportunity for bikes. While Residential and Commercial both provide opportunity for bikes, the focus was placed just on Commercial, as residential data is already captured by Population Density. The percent of Commercial land in each buffer was calculated in order to quantify the category of land use around each transit facility.

Scoring

These variables were exported into a complete table and weighted in order to best capture and accurate picture of bike opportunity at each transit facility.

For each variable, the values were divided into three categories, where category 1 describes the greatest bike opportunity, and category 3 the least. For example, buffers with the greatest total length of bike infrastructure were in category 1 for that variable. The splits for these categories were determined using histograms, in order to create categories that best evenly captured the information.

In order to create an overall understanding of bike opportunity and bring the variables together, points were assigned and weighted for each variable and category. First, for each variable, category 1 was assigned 3 points, category 2 was assigned 2 points and category 3 was assigned 1 point. Therefore, the higher point score represents greater bike opportunity.

However, weighting each of the variables equally limits the understanding of overall bike opportunity, as some variables are likely to have a greater influence on biking than others. In order to explain and capture these differences in the analysis, the variables were assigned different weights.

Multiplication Factors

The two variables which pertain most directly to biking, Mode Share and Bike Infrastructure were given the highest weight, as they are most likely to relate to overall bike opportunity.

The Mode Share variable provides an understanding of which transit facilities are located in areas where people may already have an interest in active transportation. These facilities should therefore be given higher priority, as projects and investments to improve bike parking would respond to the existing level of interest in the community. This variable relates most directly to the opportunity to promote further integration between bikes and transit, so Mode Share was given the highest weight with a multiplication factor of 1.5.

Bike Infrastructure also relates directly to bike opportunity and was given the highest weight with a multiplication factor of 1.5. Transit facilities linked to a greater amount of bike infrastructure likely have a greater need for bike parking and present opportunity for future projects. Prioritizing bike parking at transit facilities connected to a greater amount of bike infrastructure will likely be more successful at integrating bikes and transit.

The Population Density variable relates to overall usership and while it does not directly relate to bikes, a greater overall density likely presents more opportunities for bikes as well. Therefore, the Population Density variable was given a multiplication factor of 1. Transit facilities in more densely populated areas are likely to have the opportunity for higher overall use and therefore likely to have greater opportunity for bike connection as well.

The final variable, Land Use, was given the lowest weight with a multiplication factor of 0.75. While land use likely

describes the opportunity for biking to some degree, it is less directly related to biking than the other variables. In addition, the variable focuses only on Commercial land. While this provides a valuable addition to the population density in describing the context that could promote bike opportunity, it is not the only land use type that encourages biking. Therefore, Land Use was weighted the lowest, in order to capture this variable without placing too much emphasis on something less directly related to biking than the other variables

Multiplication Factor Table

	Mode Share	Bike Infrastructure	Population Density	Land Use
Multiplication Factor	1.5	1.5	1	0.75

4.3 Assumptions and Limitations

This analysis relies on a number of assumptions about the data and the variables, and as a result has several limitations that are important to note.

Mode Share

First, the Mode Share variable is described only at the municipality level. This means that transit facilities whose buffers fall entirely within the same municipality are given the same score. This may not provide the most accurate information on where people are most likely to engage in active transportation. In addition, the Mode Share data describes all active transportation, and is not specific to bikes. It also describes a broad picture of people who use active transportation in some part of their commute, and does not distinguish between people who combine active transportation with transit. With further data, this analysis could be tuned to add variables focusing specifically on biking and the combination of biking and transit at a finer scale.

Bike Infrastructure

In addition, the Bike Infrastructure variable is defined by data from Open Street Map, and it is possible that this does not provide a complete or fully accurate picture of all bike lanes and paths, as the data is created by users.

Land Use

Land Use looks only at Commercial land, and this is a potential limitation as this is not the only factor that could influence bike trips. The analysis relies on the assumption that this is one of the stronger incentives for combining bikes and transit.

Limited Variables

The analysis is also based on a limited set of variables and this is a potential limitation. It is possible that greater accuracy could be achieved by adding additional variables such as regional significance or slope. However, for the purposes of this framework it was determined that the selected variables held the most relevance and importance. This is another key assumption of the analysis.

Multiplication Factors

The multiplication factors used are based on recommendations of what were determined to be important factors in determining which areas offer the greatest bike opportunity. These perceptions are based on limited anecdotal and professional experience of a small group of professional planners and engineers. Different organizations may use different multiplication factors based on their own values, experiences and objectives.

Analysis

5.1 Scores

5.2 Maps

5.1 Scores

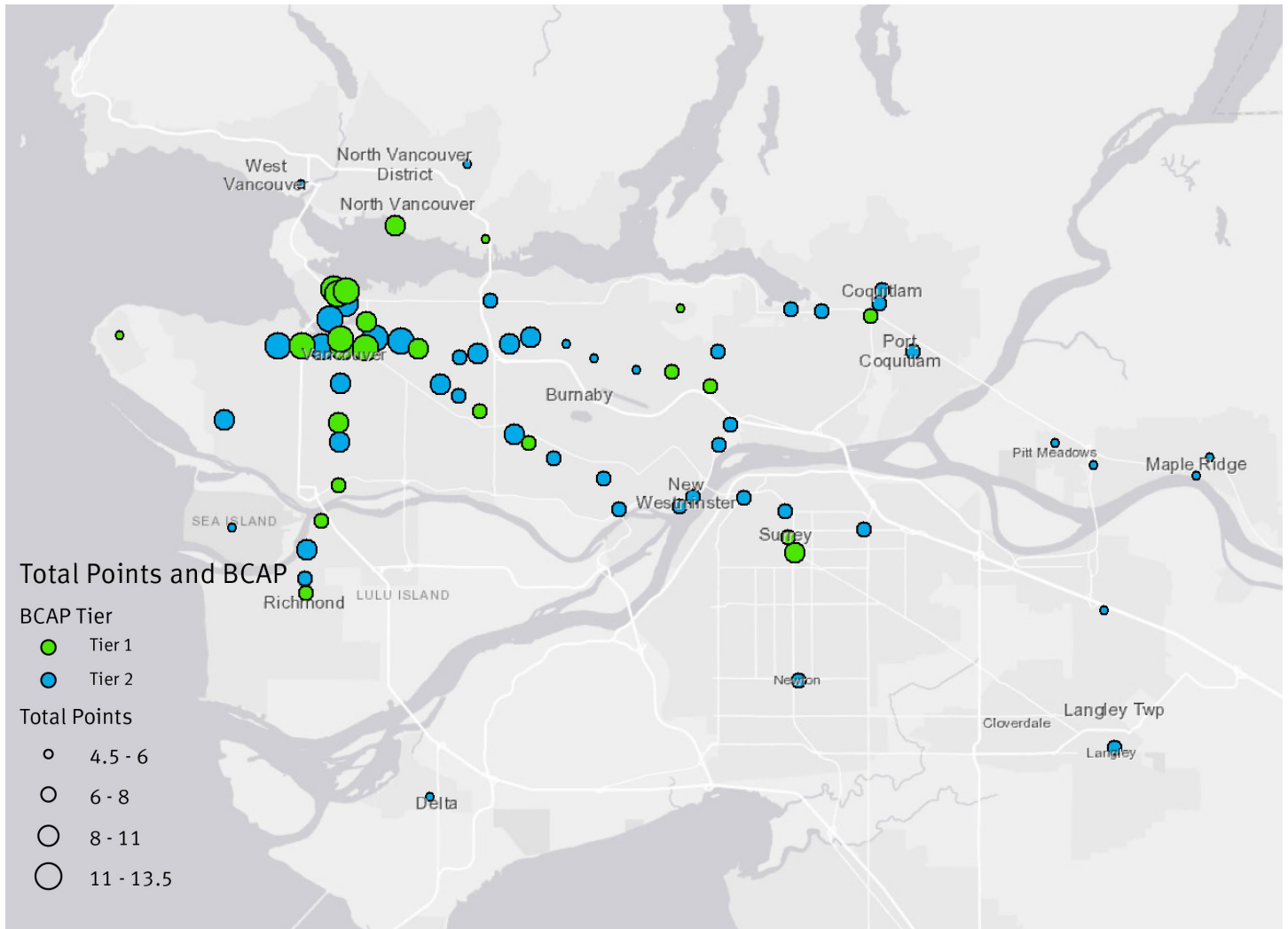
Rank	Facility Name	Mode Share	Bike Length	Population	Land Use	Total
1	Broadway - City Hall	4.5	3.75	3	2.25	13.5
2	Burrard Station	4.5	3.75	3	2.25	13.5
3	Granville/ Vancouver City Centre	4.5	3.75	3	2.25	13.5
4	Olympic Village	4.5	3.75	3	2.25	13.5
5	Waterfront Station	4.5	3.75	3	2.25	13.5
6	Stadium Station	4.5	3.75	3	2.25	13.5
7	Yaletown	4.5	3.75	3	2.25	13.5
8	Broadway Ext - Granville St Stn	4.5	3.75	3	1.5	12.75
9	Broadway Ext - Main St Stn	4.5	3.75	3	1.5	12.75
10	Broadway Ext - Great Northern Way Stn	4.5	3.75	3	1.5	12.75
11	Broadway Ext - Oak St Stn	4.5	3.75	3	1.5	12.75
12	Broadway Ext - Arbutus St Stn	4.5	2.5	3	1.5	11.5
13	VCC - Clark Station	4.5	2.5	3	1.5	11.5
14	Main St / Science World	4.5	1.25	3	2.25	11
15	Commercial - Broadway Station	4.5	1.25	3	1.5	10.25
16	King Edward Station	4.5	1.25	3	1.5	10.25
17	Lonsdale Quay	3	3	2.5	1.5	10
18	Gilmore Station	3	3	2.5	1.5	10
19	Oakridge - 41St Avenue	4.5	1.25	3	0.75	9.5
20	Langara - 49th Avenue	4.5	1.25	3	0.75	9.5
21	Nanaimo Station	4.5	1.25	3	0.75	9.5
22	Dunbar Loop	4.5	1.25	3	0.75	9.5
23	Aberdeen	1.5	2.5	3	2.25	9.25
24	Patterson Station	3	2.5	3	0.75	9.25

Rank	Facility Name	Mode Share	Bike Length	Population	Land Use	Total
25	Brentwood Station	3	1.25	3	1.5	8.75
26	Rupert Station	3	1.25	3	1.5	8.75
27	King George Station	1.5	2.5	3	1.5	8.5
28	Metrotown Station	3	1.25	3	0.75	8
29	Marine Drive Station	3	1.25	3	0.75	8
30	Joyce Station	3	1.25	3	0.75	8
31	Bridgeport Station	3	2.5	1	1.5	8
32	29th Avenue Station	3	1.25	3	0.75	8
33	Kootenay Loop	3	1.25	3	0.75	8
34	Renfrew Station	3	1.25	3	0.75	8
35	22nd Street Station	1.5	2.5	3	0.75	7.75
36	Braid Station	1.5	2.5	3	0.75	7.75
37	Edmonds Station	1.5	2.5	3	0.75	7.75
38	Scott Road Station	1.5	2.5	3	0.75	7.75
39	Sapperton	1.5	2.5	3	0.75	7.75
40	Richmond - Brighthouse Station	1.5	1.25	3	1.5	7.25
41	Coquitlam Central Station	1.5	1.25	3	1.5	7.25
42	Surrey Central Station	1.5	1.25	3	1.5	7.25
43	Lansdowne Station	1.5	1.25	3	1.5	7.25
44	Lafarge Lake-Douglas Station	1.5	1.25	3	1.5	7.25
45	Moody Centre Station	1.5	1.25	3	1.5	7.25
46	New Westminster Station	1.5	1.25	3	1.5	7.25
47	Newton Exchange	1.5	1.25	3	1.5	7.25
48	Inlet Centre Station	1.5	1.25	3	1.5	7.25
49	Lincoln Station	1.5	1.25	3	1.5	7.25
50	Guildford Exchange	1.5	1.25	3	1.5	7.25
51	Langley Centre Exchange	1.5	2.5	1	2.25	7.25

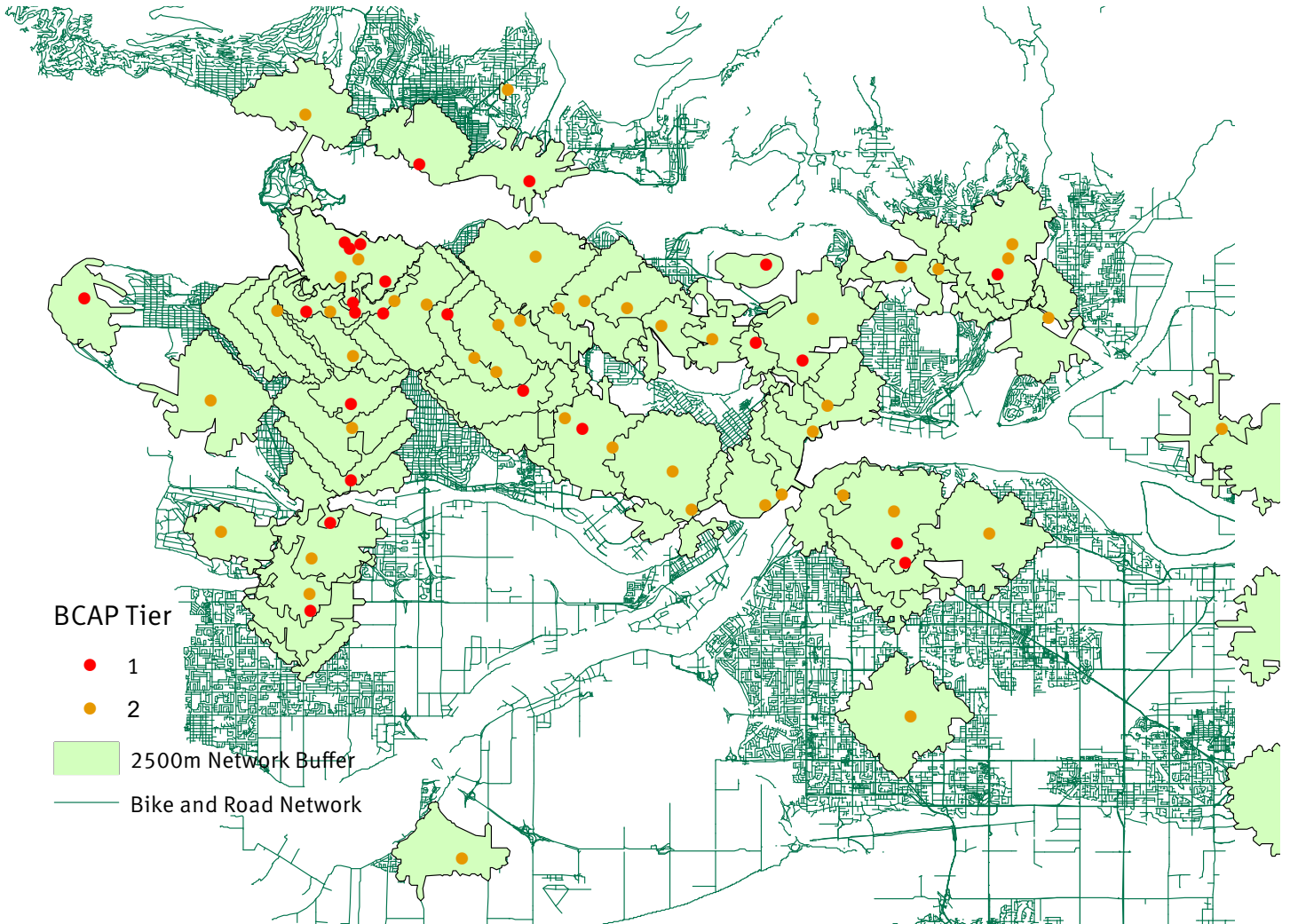
Rank	Facility Name	Mode Share	Bike Length	Population	Land Use	Total
52	Lougheed Station	1.5	1.25	3	0.75	6.5
53	Production Way	1.5	1.25	3	0.75	6.5
54	Royal Oak Station	1.5	1.25	3	0.75	6.5
55	Burquitlam Station	1.5	1.25	3	0.75	6.5
56	Columbia Station	1.5	1.25	3	0.75	6.5
57	Gateway Station	1.5	1.25	3	0.75	6.5
58	Port Coquitlam Station	1.5	1.25	3	0.75	6.5
59	White Rock Centre	1.5	1.25	3	0.75	6.5
60	Phibbs Exchange	3	1.25	1	0.75	6
61	Lynn Valley Town Centre	1.5	1.25	1	2.25	6
62	Park Royal	1.5	2.5	1	0.75	5.75
63	Holdom Station	1.5	2.5	1	0.75	5.75
64	SFU Exchange	1.5	1.25	1	1.5	5.25
65	UBC Exchange	1.5	1.25	1	1.5	5.25
66	Port Haney Station	1.5	1.25	1	1.5	5.25
67	Carvolth	1.5	1.25	1	0.75	4.5
68	Haney Place	1.5	1.25	1	0.75	4.5
69	Ladner Exchange	1.5	1.25	1	0.75	4.5
70	Lake City Way	1.5	1.25	1	0.75	4.5
71	Maple Meadows Station	1.5	1.25	1	0.75	4.5
72	Pitt Meadows Station	1.5	1.25	1	0.75	4.5
73	Sperling Station	1.5	1.25	1	0.75	4.5
74	YVR - Airport	1.5	1.25	1	0.75	4.5

5.2 Maps

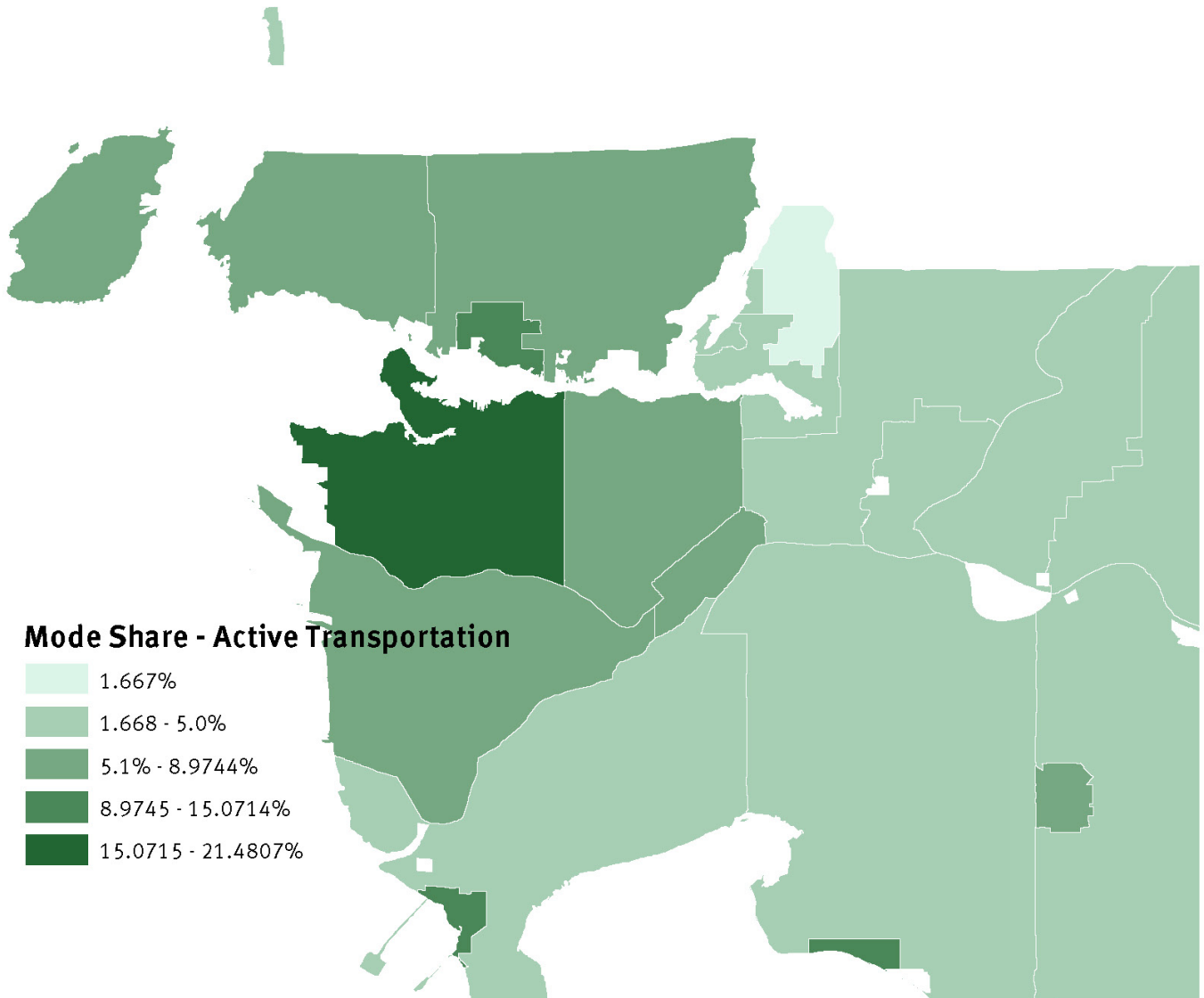
Total Points and BCAP Tiers



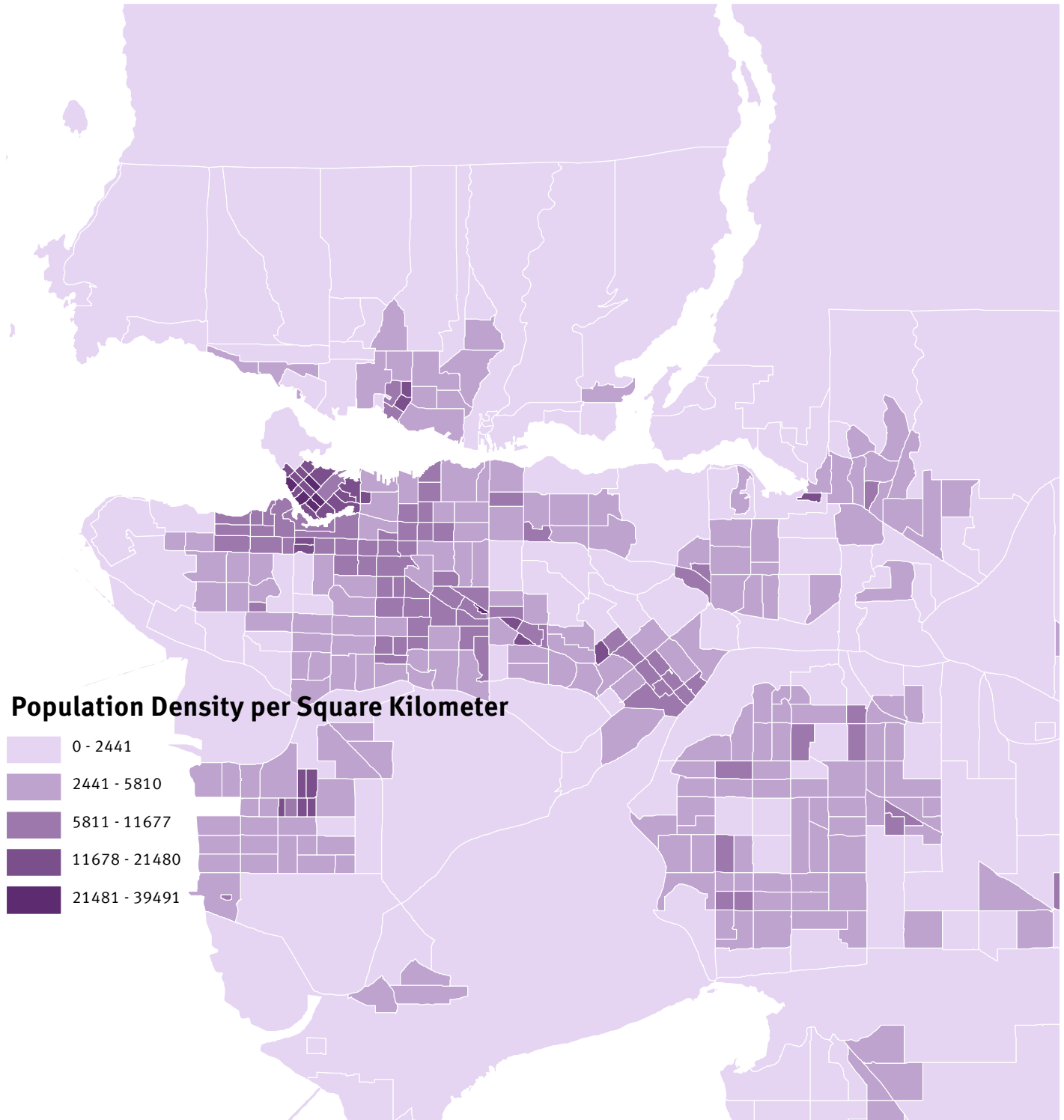
Network Buffers



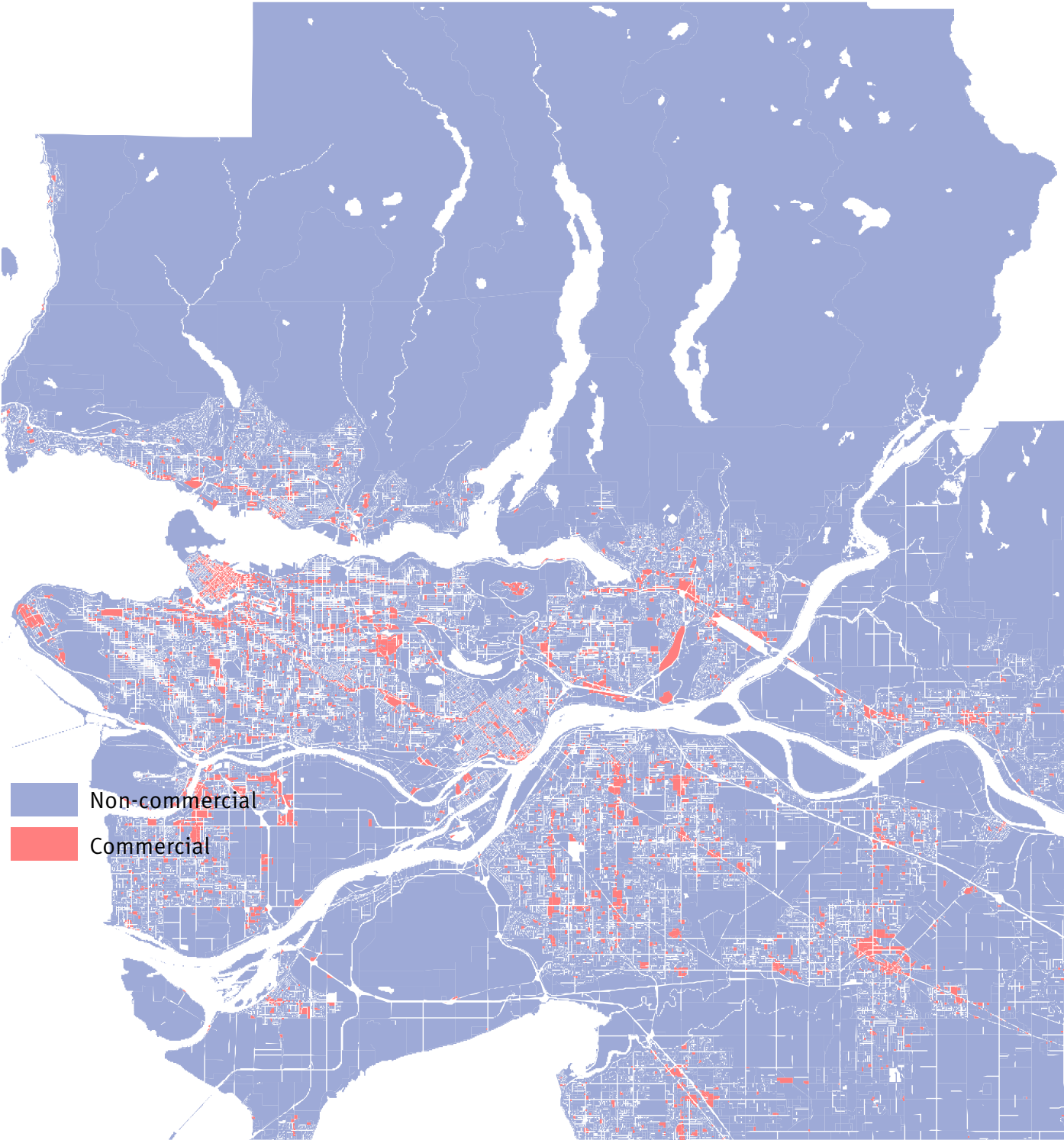
Mode Share



Population Density



Land Use



Findings and Conclusions

Findings

Based on the analysis of biking in Metro Vancouver, there is an opportunity for TransLink to develop further bike parking facilities. Increasing bike parking at transit facilities could help promote connections between cycling and transit, encourage healthy and sustainable travel and enhance overall accessibility throughout the network.

From the precedent study of bike parking at and near transit facilities in cities around the world, there are several options for bike parking that could be added to the TransLink network. The most promising options are likely Bike Parkades, Lockers (both Single-User and On-Demand), and Sheltered Parking. These options provide the best combination of security and affordability.

Bike Parkades and Single-User Lockers are currently successfully in use throughout the region. Expanding these options at transit facilities with high bike opportunity will help further integrate bikes and transit. Future investments in On-Demand Lockers and Sheltered Parking could add flexibility and reach different user groups.

The analysis of Mode Share, Bike Infrastructure, Population Density and Land Use suggests which transit facilities have the most opportunity for biking. These facilities could therefore likely benefit the most from an increase in bike parking.

Recommendations

The analysis showed that locations that saw a high degree of active mode share and high total length of bike infrastructure scored highly and therefore may warrant more investment in bike parking.

Of the 20 highest scoring transit facilities, 18 are in Vancouver. These facilities are a mix of BCAP Tier 1 and Tier 2 facilities. The top facilities are mainly in relatively urban areas with established transit facilities and services. These facilities generally have some existing connection to bike infrastructure, and some have existing bike parking options already available.

The analysis does not account for existing bike parking at transit facilities, but this should also be taken into account when planning future projects and investments. Facilities with existing bike parking options may be highly ranked for bike opportunity from the analysis, but they are likely less of a priority for new projects. Therefore, while this framework provides a tool to determine bike opportunity and priority, further research and analysis should go into planning.

The lowest ranking facilities are all in low population areas and generally have fewer connections to bike infrastructure and less commercial land use and active mode share. However, there is some information not captured by the variables and analysis that should be assessed.

For example, UBC Exchange ranks 65th in bike opportunity out of the 74 facilities studied. This would indicate that there is little opportunity or need for investment and future projects at this location. However, this is likely not the case. The results are likely skewed due to the low population on campus and resulting lack of census data. The variables used do not account for commuters and other institutional patterns. Therefore, future investments and plans should take a closer look to the specific characteristics of facilities that may not be captured by a general set of variables.

Generally, the lowest ranking facilities span across municipalities and while some of these facilities are well connected to transit and existing networks they likely present little bike opportunity.

Next Steps

Future investment in bike parking will depend on many things, including available funding, stakeholder consultation, and local context. Despite this variability, based on precedent research, it may make sense to focus larger interventions in more transit-oriented, densely populated areas. Facilities that scored highly, particularly those in areas with ample connections to formal bike infrastructure and high active mode share may be best suited for future investment.

Conclusions

Based on the analysis, transit facilities in urban areas with existing connection to bike infrastructure and high active mode share show the most opportunity for investment in bike parking. Precedent research also suggests that facilities in densely populated and transit-oriented areas may have more demand for bike parking. The highest ranking facilities in the analysis show all of these characteristics, and therefore may be prioritized for future investment and bike parking projects.

The precedent study showed many different case studies of bike parking types around the world. In the local context, Bike Parkades, Lockers and Sheltered Parking are the options that are the most affordable to install and maintain, while also providing the necessary security. These types of bike parking options should be implemented at the high ranking facilities as determined by the analysis.

Determining the type of bike parking best suited for each facility will require a more comprehensive case-by-case analysis. Some factors to consider will likely include funding, available space and immediate context. While this will require a greater level of detail than was used in this analysis, this work provides a framework to begin to determine the prioritization and planning of future investment in bike parking at transit facilities.



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